

Appl. No. 10/720,311
Examiner: CHEN, KIN-CHAN, Art Unit 1765
In response to the Office Action dated August 29, 2005

Date: November 25, 2005
Attorney Docket No. 10113261

REMARKS

Applicant thanks the Examiner for acknowledging Applicant's claim to foreign priority and receipt of the certified copy of the priority document. Responsive to the Office Action mailed on August 29, 2005 in the above-referenced application, Applicant respectfully requests amendment of the above-identified application in the manner identified above and that the patent be granted in view of the arguments presented. No new matter has been added by this amendment.

Present Status of Application

Claims 1-29 are pending in the application. Claims 13 and 21 are objected to for informalities. Claims 1-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tews (US 6,534,376) in view of Lim et al (US 6,828,185) as evidenced by Hsu et al (US 6,143,645). Claims 16-20 and 22-29 are allowed.

In this paper, claims 13 and 21 are amended according to the suggestion of the Examiner. Applicant submits that the objections to the claims are thereby overcome. Claims 1 and 10 are amended to recite novel and nonobvious features of the present invention. Support for the amendment can be found on page 5, lines 23-29, page 6, lines 1-5, and FIG. 2B~2D of the specification.

Reconsideration of this application is respectfully requested in light of the amendments and the remarks contained below.

Allowable Subject Matter

Applicant thanks the Examiner for the allowance of claims 16-20 and 22-29. Applicant further submits that the amendment of claim 21 to overcome the objection thereto puts this claim into condition for allowance.

Rejections Under 35 U.S.C. 103(a)

Claims 1-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tews in view of Lim et al as evidenced by Hsu et al. To the extent that the grounds of the rejections may be applied to the claims now pending in this application, they are respectfully traversed.

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Tews teaches a process flow for forming a sacrificial collar within a deep trench of a semiconductor memory cell. Lim et al and Hsu et al each teach plasma nitridation methods.

Whether taken alone or in combination, Tews, Lim et al, and Hsu et al, fail to teach or suggest a method for forming a bottle-shaped trench, comprising the steps of providing a semiconductor substrate with a trench having a pad stack layer thereon; filling a mask layer into the lower portion of the trench; **plasma nitriding a sidewall of the trench of the substrate using the mask layer as a mask to form a sidewall nitride layer on the trench sidewall**; removing the mask layer; and etching the lower portion of the trench to form a bottle-shaped trench using the sidewall nitride layer as a mask, as recited in amended claim 1.

MPEP 2142 reads in part:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaack*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In connection with the third criteria, MPEP 2143.03 goes on to state:

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).

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On pages 2-3 of the office action, the examiner asserts that Tews teaches that the lower portion of the trench may be filled with a mask layer, such as photoresist material, and that nitridation may be applied to form a sidewall nitride layer on the trench sidewall.

However, Tews teaches:

A nitride liner layer 120 is deposited or formed over the wafer 100 See column 4, lines 54-55 of Tews.

A thin semiconductor layer 122 is deposited or formed over the nitride liner layer 120 ... See column 4, lines 60-61 of Tews.

A first oxide layer 124 is formed over semiconductor layer 122 ... See column 4, lines 66-67 of Tews.

Exposed portions of first oxide layer 124 not covered by resist 116 are removed ... See column 5, lines 13-15 of Tews.

The wafer 100 is exposed to a nitridation process, as shown in FIG. 7, to **form a thermal nitride layer 128 over exposed portions of the semiconductor layer 122**. Preferably the nitridation process comprises exposing the wafer 100 to a nitrogen-containing chemical, such as NH_3 . Because there is a time delay between nitridation of the semiconductor layer 122 and the nitridation of the first oxide layer 124, the nitride layer 128 comprises a very thin layer of nitride, e.g. about 15Å of silicon nitride. **The nitride layer 128 is grown on over the semiconductor layer 122 only**, and in particular, **nitride is not grown over first oxide layer 124**, in accordance with an embodiment of the invention. See column 5, lines 37-47 and Figs. 5-7 of Tews [emphasis added]

Thus, Tews teaches forming a nitride liner layer 120 over the wafer 100, forming a thin semiconductor layer 122 over the nitride liner layer 120, forming a first oxide layer 124 over semiconductor layer 122, etching first oxide layer 124 to expose portions of semiconductor layer

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layer 122. Finally, a thermal nitride layer 128 is formed over exposed portions of the semiconductor layer 122, which is itself deposited over nitride liner layer 120. This method is a complicated multi-step process, resulting in higher cost and manufacture duration.

To the contrary, claim 1 recites plasma nitriding a sidewall of the trench of the substrate using the mask layer as a mask to form a sidewall nitride layer on the trench sidewall. As noted on page 6, lines 1-5 of the specification, the fabrication of the sidewall nitride layer by the above-recited method is achieved in one step and is simpler than in the conventional method.

In addition, while Lim and Hsu teach plasma nitridation methods, neither teaches nor suggests the above-emphasized limitations of claim 1.

Whether taken alone or in combination, Tews, Lim et al, and Hsu et al, fail to teach or suggest a method for forming a bottle-shaped trench, comprising: providing a semiconductor substrate with a trench having a pad stack layer thereon; filling a photoresist layer into the lower portion of the trench; plasma nitriding sidewall of the trench of the substrate to form a sidewall nitride layer on the pad stack layer and the trench sidewall, wherein the plasma nitriding step has a process temperature of about 25~100°C; removing the photoresist layer; and etching the lower portion of the trench to form a bottle-shaped trench, as recited in amended claim 10.

For the same reasons discussed in connection with claim 1, it is Applicant's belief that none of the cited art teaches or suggests the above-emphasized limitations of claim 10.

Consequently, it is Applicant's belief that even when taken in combination, the prior art references relied upon by the Examiner do not teach or suggest all the limitations of claims 1 and 10. For at least this reason, a *prima facie* case of obviousness cannot be established in connection with these claims. Furthermore, as it is Applicant's belief that a *prima facie* case of obviousness is not established for claims 1 and 10, the Examiner's arguments in regard to the dependent claims are considered moot and are not addressed here. Allowance of claims 1-15 is respectfully requested.

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Conclusion

The Applicant believes that the application is now in condition for allowance and respectfully requests so.

Respectfully submitted,



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